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ENVIRONMENTAL QUALITY PROFILE 1976
technical supplement

OREGON

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16. ABSTRACT

This report is a technical supplement to the 1976 REGIONA ENVIRONMENTAL QUALITY PROFILE (EPA REGION X) and is designed to inform the reader about the general status of the environment within the state of Oregon. It is designed to report on the present status of Oregon air and water quality, trends in that quality, an analysis of the causes and effects of observed pollution problems and EPA's view of the near term outlook for solving these problems.

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SUPPLEMENT

1976 ENVIRONMENTAL QUALITY PROFILE

FOR OREGON

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1976 ENVIRONMENTAL QUALITY PROFILE SUPPLEMENT FOR OREGON

INTRODUCTION

State, federal, and local environmental quality control agencies maintain monitoring networks to scientifically measure the quality of our environment. These monitoring networks are invaluable in determining where pollution problems exist and to measure the success or failure of abatement and pollution prevention programs.

The Seattle Regional Office of the Environmental Protection Agency annually evaluates all data collected by northwest pollution control agencies and submitted to the EPA computer data storage systems. We feel the public should be made aware of the results of these evaluations. This document and similar future documents are designed to report on the present status of northwest air and water quality, trends in that quality, an analysis of the causes and effects of observed pollution problems and our view of the near term outlook for solving these problems. This report is a technical supplement to the 1976 Regional Environmental Quality Profile and is designed to inform the reader about the general status of the environment within the state.

The reader may find a few inconsistencies between this supplement and the 1976 Regional Environmental Quality Profile due to the continual profile upgrading process which includes improvement of evaluation and presentation techniques. These changes are the result of our readers comments and suggestions. Formulating useful and accurate indices of environmental quality is a difficult task. Additional suggestions for improving the information presented in this document would be appreciated. Please direct your comments to the Office of the Regional Administrator, U. S. Environmental Protection Agency, 1200 Sixth Avenue, Seattle, Washington 98101.

REGIONAL AIR QUALITY PROFILE

OVERVIEW

Air pollution--as pollutant concentrations in excess of those established by National health-related air quality standards--occurs in every State in Federal Administrative Region X. Standards for four of the most widespread pollutants were exceeded in the State of Washington for the three year period ending in 1974. Alaska and Idaho exceeded standards for two of the four. Three standards were exceeded in Oregon. Frequency of excessive pollutant concentrations, as measured by number of violation-days was greatest in sparsely populated Idaho, least in Oregon. (A violation-day, for the purposes of this report, was established whenever a standard was exceeded in a county.) More serious "alert level" pollutant concentrations were recorded most often in Alaska, least often in Oregon.

TABLE 1 - REGION X STATES

	Concentrations Exceeding Standard				Violation-Days	
	Carbon Monoxide	Photo Oxidants	Particulate Matter	Sulfur Dioxide	Standard Exceeded	Alert Level
Alaska	X		X		412	174
Idaho			X	X	446	149
Oregon	X	X	X		301	40
Washington	X	X	X	X	368	48

Excessive pollutant levels were concentrated in nine Region X communities that together accounted for 72 percent of all violation-days and 74 percent of all alert level violation-days. The core cities of the Region's seven standard metropolitan statistical areas were responsible for just under half of all violation-days and just under two-fifths of all alert level violation-days. But two fairly small communities, Fairbanks, Alaska and Kellogg-Wallace, Idaho, exceeded any of the larger cities in numbers of times excessive pollutant concentrations were recorded, and were responsible for almost half of all recorded pollutant concentrations above the alert level.

TABLE 2 - PRINCIPAL CITIES

	Concentrations Exceeding Standard				Violation-Days	
	Carbon Monoxide	Photo Oxidants	Particulate Matter	Sulfur Dioxide	Standard Exceeded	Alert Level
Seattle	X	X	X		149	16
Portland	X	X	X		165	30
Spokane	X		X		82	3
Tacoma	X	X	X		43	5
Anchorage	X		X		142	90
Boise			X		11	6
Eugene	X	X	X		56	2
Salem	X	X			23	1
Fairbanks	X		X		203	73
Kellogg-Wallace			X	X	217	69

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A great deal of Region X's air pollution can be attributed to the automobile. Just under half of Alaska's violation-days can be traced to the automobile and the bulk of Oregon's and Washington's problems (in violation-days) can be traced to the automobile. The bulk of Oregon's and Washington's standards violation problems were due to carbon monoxide and photochemical oxidant concentrations that occurred around the largest cities of the two States. Those pollutants could be traced almost entirely (i.e., 80 to 90 percent) to automobile exhausts. Because well over half of the Region's population lives in and around the six cities in which such pollution occurs, population exposure to risk as a consequence of automobile emissions is a significant public health problem of the Pacific Northwest and Alaska.

TABLE 3 - AUTO-RELATED VIOLATION DAYS

Alaska	42.2%
Anchorage	16.9%
Fairbanks	77.8%
Idaho	No Data
Oregon	85.0%
Portland	97.6%
Eugene	85.7%
Salem	100.0%
Washington	66.8%
Seattle	99.3%
Spokane	82.9%
Tacoma	46.5%
Region X	45.1%

AIR QUALITY IN OREGON

Under the Clean Air Act of 1970, the Environmental Protection Agency has established National standards that specify maximum permissable levels of pollutant materials in air.

Standards for the principal and most widespread pollutants--total suspended particulate matter, sulfur dioxide, carbon monoxide, photochemical oxidants, and oxides of nitrogen--are divided into two categories. Primary standards are set at levels intended to protect human health. Secondary standards are set at levels intended to protect against other forms of damage caused by air pollution.

The material that follows is an attempt to describe simply what is known about air quality in the State of Oregon in terms of its adherence to National primary air quality standards. Those standards have been established to protect against the following specific health effects that have been demonstrated to stem from the particular pollutant:

Total suspended particulates--aggravation of asthma and chronic lung diseases, increased cough, chest discomfort, restricted activity, aggravation of heart and lung disease symptoms in the elderly, increased death rate;

Sulfur dioxide--aggravation of asthma, aggravation of heart and lung disease symptoms in the elderly, increased lung illness, increased death rate;

Carbon monoxide--interference with mental and physical activity, reduced capacity in persons suffering from heart and other circulatory disorders;

Photochemical oxidants--aggravation of asthma and chronic lung disease, irritation of the eye and of the respiratory tract, decreased vision, reduced heart and lung capacity;

Oxides of nitrogen--increased chronic bronchitis.

The material is presented in graphic form. It is intended to depict:

1) where, and how often, primary standards were exceeded in 1974,

2) location and frequency of severe concentrations of health damaging pollutants in 1974,

3) indicated trend of pollutant concentrations in the period 1972 to 1974, and

4) sources of the principal pollutants found to be in excess of the primary standard in 1974.

POLLUTANTS IN EXCESS OF HEALTH STANDARDS

During the three year period ending in 1974, eleven of Oregon's thirty-six counties experienced recorded concentrations of pollutants that exceeded the allowable maxima specified by primary air quality standards. The counties are ranked in Figure 1 below according to the average number of days per year in which a given standard was exceeded.

Particulate matter was the most widespread cause of an exceeded standard. Concentrations above the primary standard occurred in ten counties.

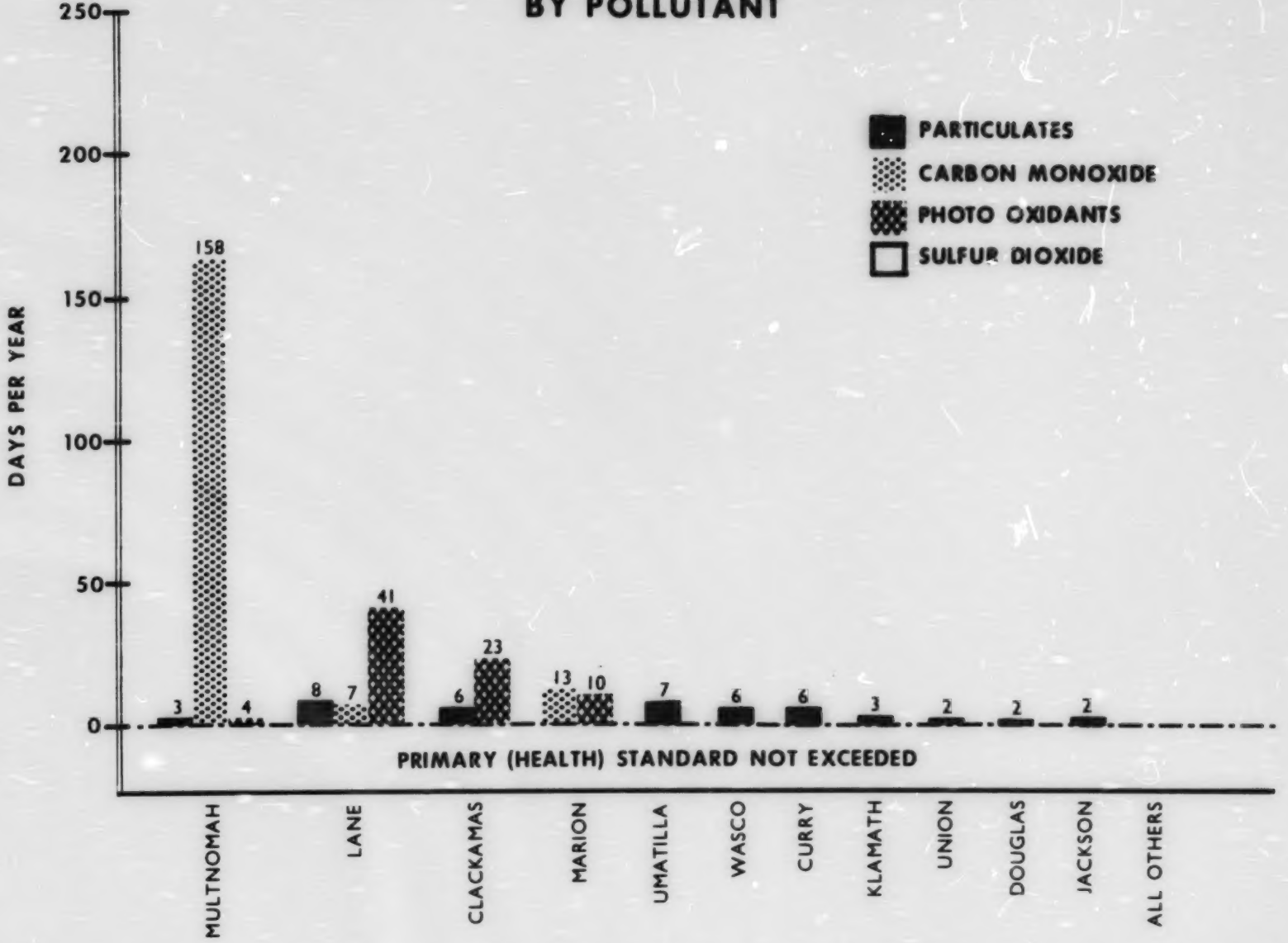
Carbon monoxide produced the largest number of days in which a standard was exceeded. Total days when the standard was not met amounted to 178, as compared to 123 days for the combination of all other primary standard pollutants. The standard was, however, exceeded only in three metropolitan area counties.

The photochemical oxidant standard was exceeded in every county that did not consistently meet the carbon monoxide standard, as well as in Clackamas County where the carbon monoxide standard was met.

Pollutant concentrations in excess of health standards occurred largely in Oregon's metropolitan areas. Two of three Oregon counties comprising the Portland metropolitan area accounted for 194 combined days in which standards were exceeded. Lane (Eugene) and Marion (Salem) Counties together experienced 79 days in which standards were not met. All of the rest of the State produced only 28 days in which health standard levels for pollutants were not met.

Figure 1

OREGON
DAYS EXCEEDING HEALTH STANDARD BY POLLUTANT



SEVERITY OF POLLUTION

Primary air quality standards include three degrees of risk, according to level of pollutant concentrations. The nature of potential health damage is the same at each level, but the probability of damage and the proportion of the population that is predisposed to health impairment increases as the amount of pollutants in air increases. There are distinct thresholds that indicate the degree of risk that is believed to be associated with certain pollutant concentrations, and these are recognized in the primary air quality standards. As the higher concentrations occur, the enhanced danger of the consequent pollution is designated by an air quality standard category. "Alert" level pollutant concentrations are thought to be significantly more serious than lower concentrations exceeding the primary standard. "Warning" levels are thought to be significantly more serious than alert.

TABLE 4

Threshold Pollutant Concentrations
(per cubic meter of air)

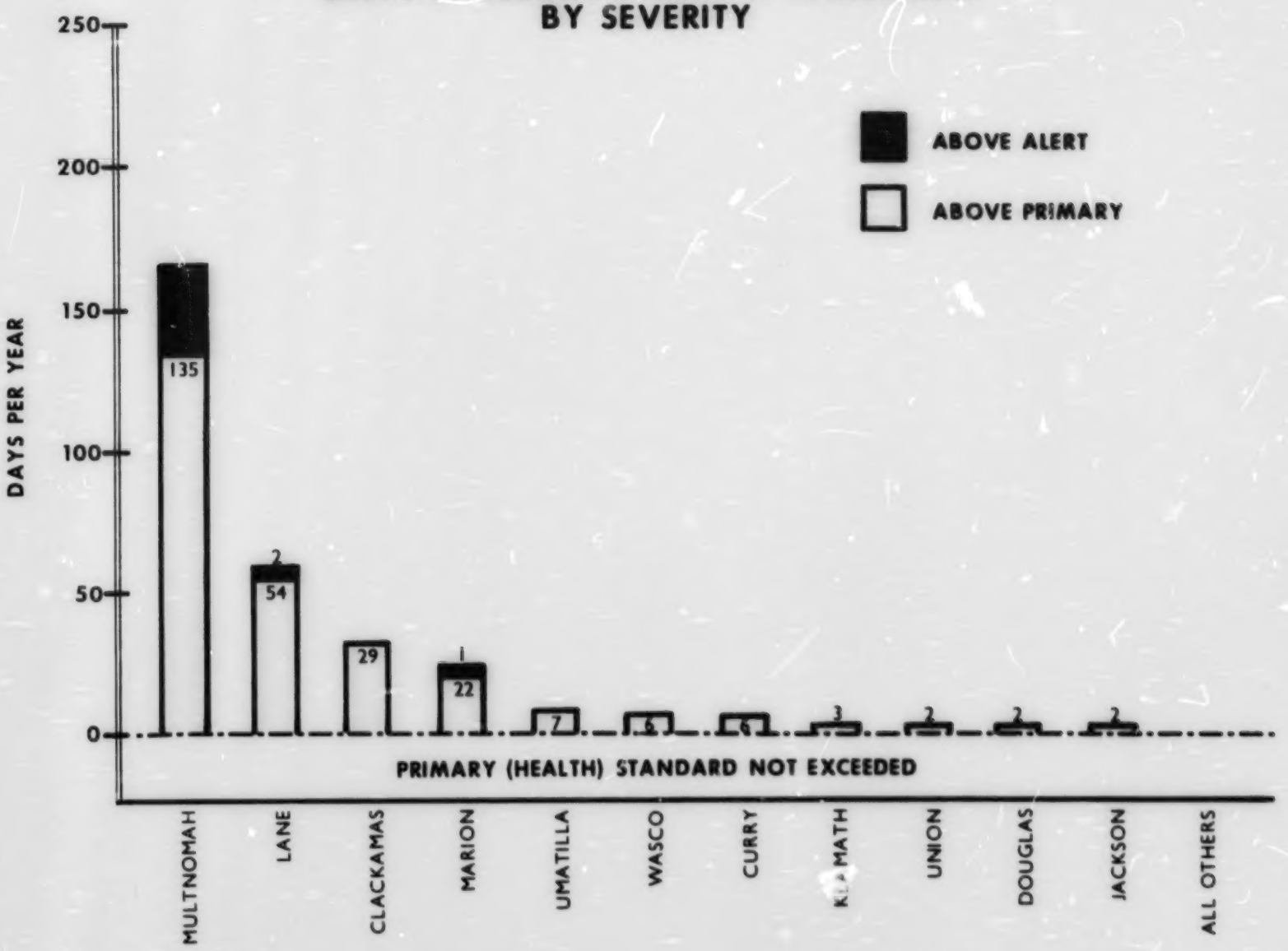
Pollutant	Standard	Alert	Warning
Particulates (24 hour)	260 micrograms	375	625
Sulfur dioxide (24 hour)	365 micrograms	800	1,600
Carbon monoxide (8 hour)	10 milligrams	17	34
Oxidants (1 hour)	160 micrograms	200	800

In 1974 (Figure 2), at least 40 of the 301 instances in which health standards were exceeded in Oregon involved concentrations at or above the alert level, a proportion somewhat lower than in other Region X States. Three quarters of those more serious conditions occurred in Portland.

Figure 2

OREGON

DAYS EXCEEDING HEALTH STANDARD BY SEVERITY



POLLUTANT SOURCES: CARBON MONOXIDE

The graph in Figure 3 indicates the estimated distribution of sources of carbon monoxide in those Oregon counties in which a primary air quality standard was exceeded in 1974.

Mobile sources--automobiles and other transportation equipment--were responsible for the largest share of carbon monoxide in all of those counties in which the carbon monoxide standard was exceeded, accounting for almost 90% of the four counties' gross carbon monoxide production of over 500,000 tons. Thus the predominate source of Oregon's air pollution incidents, and the source of the pollution that affected the greatest number of persons, was the automobile, with the other mobile sources contributing to its effect.

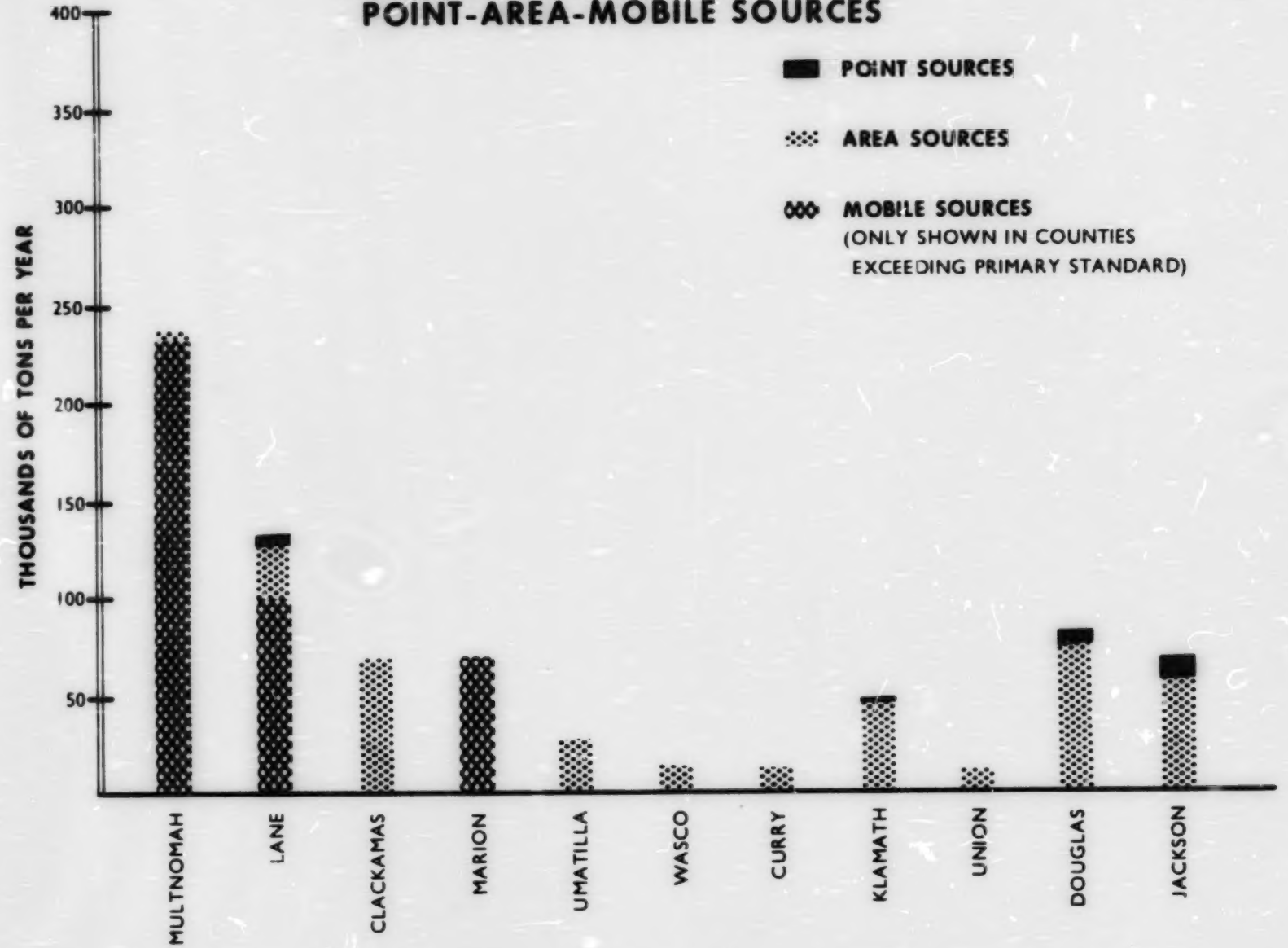
Point sources of carbon monoxide were inconsequential, their aggregate production less than 25,000 tons of almost 800,000 tons (including that of the counties in which the carbon monoxide standard was not exceeded).

The indicated volume of production of area sources--close to 300,000 tons for the eleven counties--is deceptive, in that no effort was made to distinguish mobile sources from other area sources in those counties in which the carbon monoxide standard was not exceeded. It may safely be assumed that mobile sources dominated carbon monoxide production in those counties, as well as in the more urbanized areas in which the standard was not met. And because production of photochemical oxidants and carbon monoxide is related, the general distribution of oxidant sources is probably very similar to that for carbon monoxide.

Figure 3

OREGON

CARBON MONOXIDE EMISSIONS
POINT-AREA-MOBILE SOURCES



POLLUTANT SOURCES: TOTAL SUSPENDED PARTICULATE MATTER

Figure 4 indicates the estimated distribution of sources of particulate matter in those Oregon counties in which a primary air quality standard was exceeded in 1974.

Point sources--large, recognizable features such as factories--were responsible for somewhat more than half of aggregate particulate production in the eleven counties that exceeded primary standards. In total, point source particulate emissions amounted to about 38,000 tons of the estimated 71,000 tons of particulate material produced in 1974.

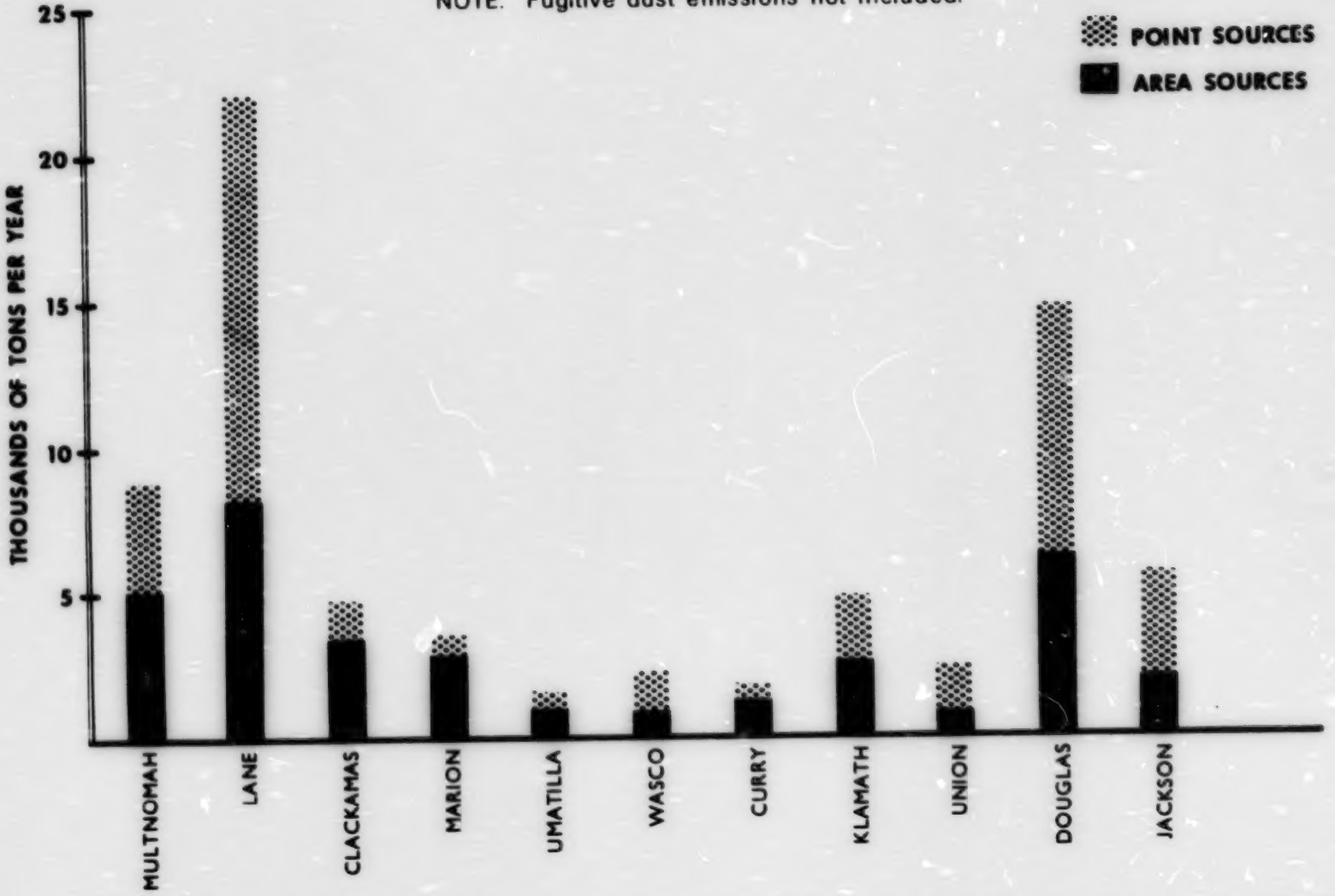
Area sources--space heating, transportation devices, brush and field burning, wind blown dust, etc.: the variety of small, intermittent sources of pollutants too numerous, changeable, and insignificant in themselves to be cataloged, though in combination they may generate large volumes of pollutants--were responsible for more than 33,000 tons of particulate matter. In Lane County, where burning of grass stubble is a massive if limited area source of particulate matter, estimated area source production was 8,000 tons of particulates in 1974.

Figure 4

OREGON

POINT AND AREA SOURCE PARTICULATE EMISSIONS

NOTE: Fugitive dust emissions not included.



AIR POLLUTION TRENDS

The chart on Figure 5 shows indicated trends of pollutant concentrations in Oregon counties, as those trends may be derived from the air monitoring record for the period 1972 through 1974.

Blue boxes indicate that there is no evidence that the specified air quality standard has been exceeded. Where circles occur within the box, the presumed compliance with standards is not based on measurements, but is derived from judgment and a knowledge of pollutant sources.

Yellow boxes indicate that a standard has been exceeded, without concentrations reaching the alert level. An upward pointing arrow indicates that measured concentrations of the specified pollutant appear to be increasing--that the propensity for pollution to occur is rising. A downward pointing arrow indicates that concentrations appear to be receding.

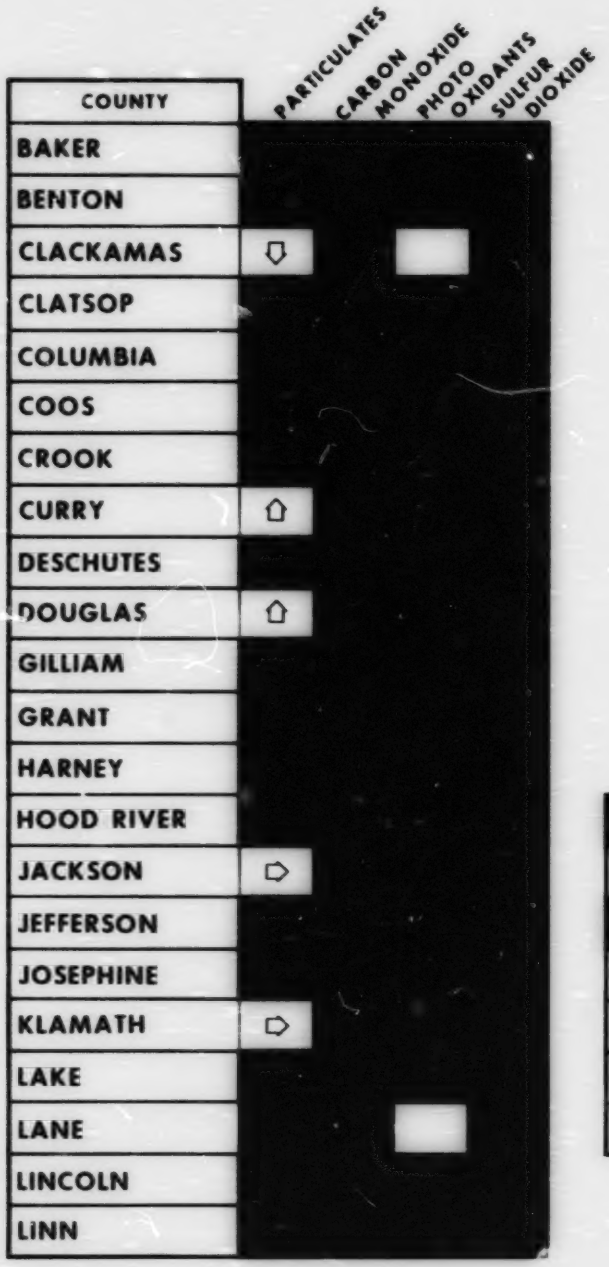
Red boxes are used where a pollutant concentration has exceeded the alert level. Again, the arrow within the box indicates the apparent direction of the pollutant's concentration.

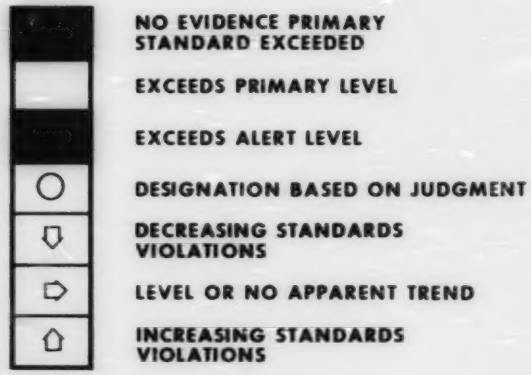
On the balance, there seems to have been improvement in Oregon's air quality conditions between 1972 and 1974. Grounds for optimism are provided by the consistent decline of pollutant concentrations in the Willamette Valley counties that contain the bulk of Oregon's population. Elsewhere, trends are less clearly defined. It should be noted, however, that fluctuating meteorological conditions make it unwise to draw more than tentative conclusions about air quality trends on the basis of a period as short as three years.

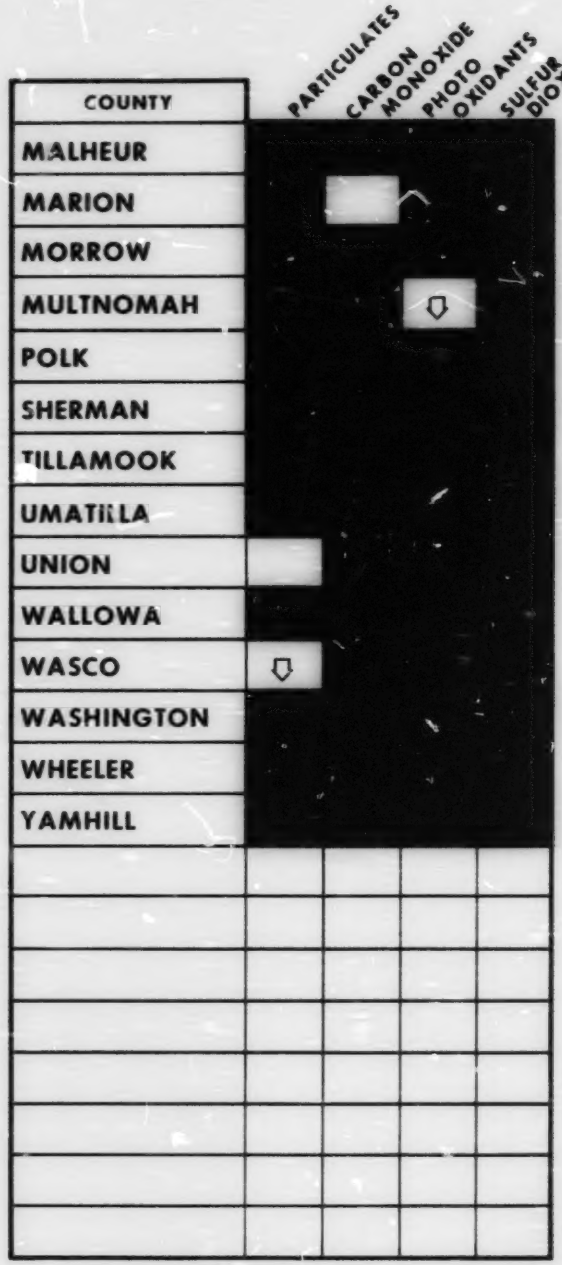
Figure 5

ATTAINMENT STATUS AND TRENDS IN AIR POLLUTION

OREGON







NEAR TERM OUTLOOK

With the exception of the Portland Metropolitan Area's auto-related problems and the similar, lesser problems in other Willamette Valley urban areas, Oregon's air quality is good. Existing trends are generally favorable; and there is nothing in the review of the kinds, frequencies, and sources of pollutant concentrations that exceed the standards to indicate a turn for the worse. As for existing air pollution, the prognosis varies according to pollutant.

Particulates, the broadest form of pollutants in excess of the standards, would appear to offer the best prospects for immediate improvement. Though excessive particulates are widespread, the frequency and duration of concentrations in excess of the primary standard are slight. Point sources predominate; and the combination of source identification with the availability of control technology indicates that abatement of pollutional conditions is possible. Indeed, a good deal of the State's particulates problems had been obviated by precisely that combination of circumstances prior to 1972. Total elimination of particulate concentrations in excess of standards is not considered feasible because of such natural and man-made sources as wind blown dust--particularly in eastern Oregon agricultural areas--forest fires, construction, etc. An additional, local complication is provided by the southern Willamette Valley practice of burning grass field stubble to control nematodes--a practice that produces enormous quantities of particulate matter in a very limited period. Such complications aside, the bulk of particulate-associated air quality problems is very likely to be eliminated within the next three to five years.

Carbon monoxide and associated photochemical oxidant excursions beyond the standard present distinctly less optimistic prospects. The private automobile is responsible for almost 90% of carbon monoxide production in those counties where the standard is not met; so that the very number of sources that must be controlled presents a formidable obstacle to near term standards attainment. Carbon monoxide reduction devices are, of course, an integral component of all recent model year autos. So the reduction of carbon monoxide concentrations is essentially a matter of gradual replacement of the existing stock of autos with new units that incorporate the control technology--a long term, probabilistic process that is retarded by growth in total automobile usage. This approach assumes that these devices are operated and maintained properly which requires an inspection and maintenance program. Modification of transportation practice have the power to accelerate the rate of progress: reduction in use of high density traffic corridors, smoothing of peaks in traffic patterns, greater attention to auto maintenance, and reduction of total vehicle miles through growth in average numbers of passengers per vehicle by use of mass transit or other techniques, all offer marginal improvements in carbon monoxide production trends. But the main avenue of pollution control at this time is replacing older autos with exhaust-controlled ones; and that suggests that the advance toward conformity to the carbon monoxide standard over the next three to five years will be steady but slow--certainly less than is desirable for public health maintenance.

REGIONAL WATER QUALITY PROFILE

OVERVIEW

Relative pollution of the non-marine waters of major Pacific Northwest rivers is indicated on the accompanying graphs. Figure 6 depicts the degree of pollution in each major regional river reach and Figure 7 shows the location of the river reaches. Similar determinations are not available for Alaskan waters due to a lack of necessary data. EPA and the State of Alaska are currently working together toward the development of a water quality monitoring program that will provide the same depth of information that is available in other Region X states.

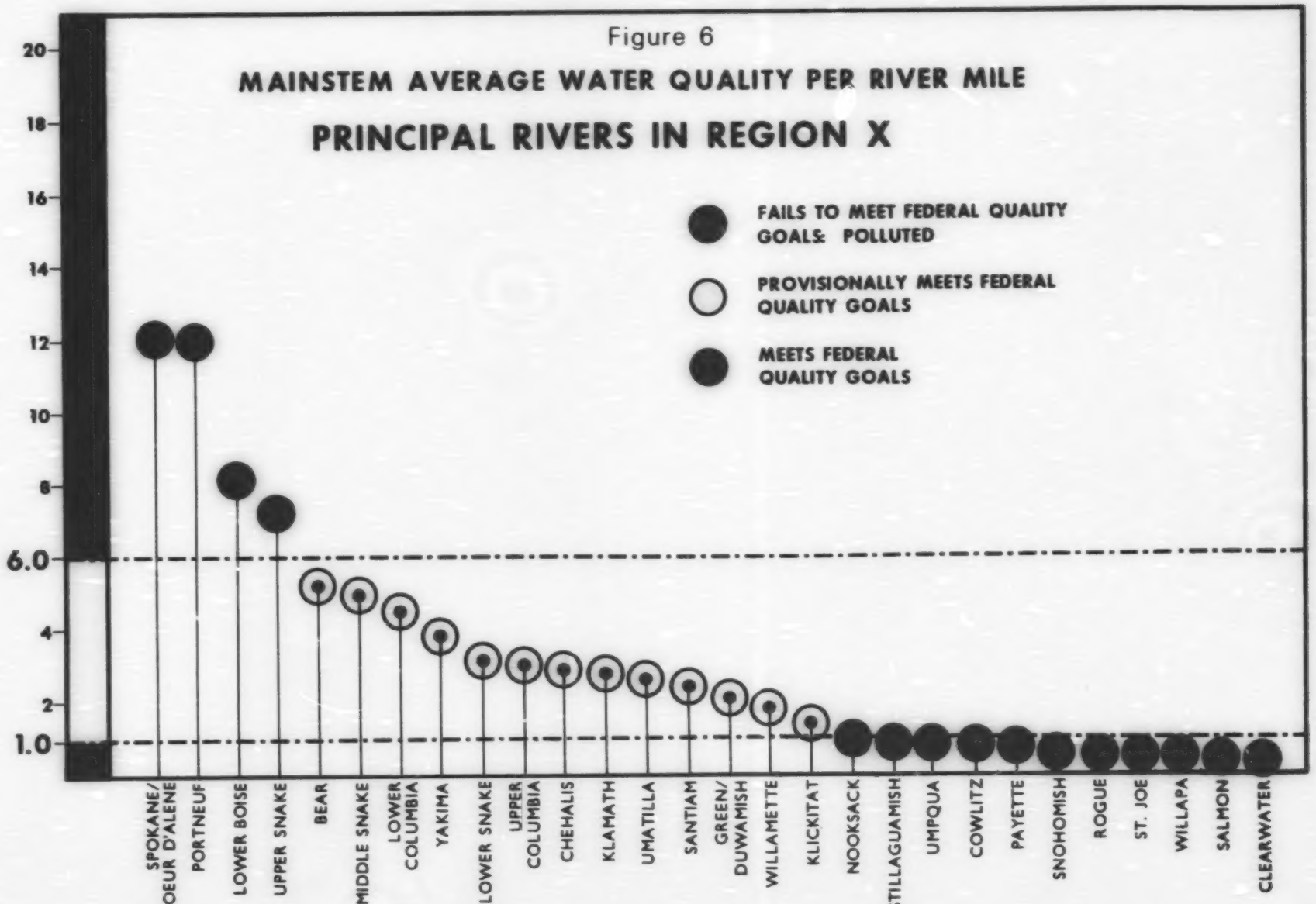
The basis of comparison between waters of the Pacific Northwest is an eleven part Water Quality Index (WQI) that compares measured water quality conditions during the last five years with federal criteria recommended by the National Academy of Sciences.1/ Approximately four hundred (400) water quality stations located on a majority of the streams throughout the three Northwest states were used in the evaluation. Measured water quality constituents from various federal, state and local agencies are stored in EPA's data storage and retrieval system called STORET. The federal water quality criteria are recommended threshold concentrations in water which are considered suitable for propagation of fish, the use by wildlife, and for recreation. The eleven criteria groups considered in the index are listed in Table 5.

The index number for any river segment is calculated by multiplying the frequency of criteria violations for each constituent by a severity weighting function which is based on the magnitude of violation. Individual river segment index numbers are multiplied by a ratio of segment river miles to total river miles, then summed to obtain average WQI for the total river. The WQI number spans a scale that may run from 0.0 (no measured evidence of pollution) to 110.0 (severe pollution in all criteria groups at all times); however, most Pacific Northwest streams fall into a category below the scale of 20.0. General, federal criteria were employed for the particular index construction rather than the specific state water quality standards that apply to the various waterbodies. State water quality standards reflect local natural conditions whereas federal criteria are based upon field and laboratory studies which have been shown nationally to correlate with biological, recreational, and health problems. Federal criteria are in some cases more stringent than state standards. Index values computed from federal criteria will therefore tend to present a more conservative estimate of water quality than if actual state standards were applied.

The graphs of water quality indices are divided into three segments that reflect professional judgment as to the significance of the values. An index number greater than 6.0 is considered to be characteristic of streams or stream segments that do not meet the goals of the Federal

1/ EPA R3.033 Ecological Research Series, Water Quality Criteria 1972, U.S. Government Printing Office, March 1973.

Figure 6


MAINSTEM AVERAGE WATER QUALITY PER RIVER MILE
PRINCIPAL RIVERS IN REGION X
FAILS TO MEET FEDERAL QUALITY GOALS& POLLUTED
PROVISIONALLY MEETS FEDERAL QUALITY GOALS
MEETS FEDERAL QUALITY GOALS
20
18
16
14
12
10
8
6.0
4
2
1.0
SPOKANE/ COEUR D'ALENE
PORTNEUF
LOWER BOISE
UPPER SNAKE
BEAR
MIDDLE SNAKE
LOWER COLUMBIA
YAKIMA
LOWER SNAKE
UPPER COLUMBIA
CHEHALIS
KLAMATH
UMATILLA
SANTIAM
GREEN/ DUWAMISH
WILLAMETTE
KLICKITAT
NOOKSACK
STILLAGUAMISH
UMPQUA
COWLITZ
PAYETTE
SNOHOMISH
ROGUE
ST. JOE
WILLAPA
SALMON
CLEARWATER

Water Pollution Control Act--bodies of water that are, based upon federal criteria, definitely polluted. An index number less than 1.0 is considered to be equivalent to unpolluted natural conditions. The area between 1.0 and 6.0, where most Pacific Northwest rivers fall, is generally consistent with the goals of the Federal Water Pollution Control Act, but with local or seasonal deviations.

The water quality index is used in this report for the purpose of comparing twenty-eight Pacific Northwest rivers within the States of Idaho, Oregon, and Washington. In each major river discussed in this section, the WQI is a summation of the significant individual stream segments that make up each river. The resultant river WQI is the weighted average of the individual WQIs within the river and may not reflect local pollution problems existing in some of the individual segments. For ease of presentation, colors on Figure 7 represent the average WQI range for the mainstem of each river; however, the actual WQI could change throughout each river segment.

As Figures 6 and 7 indicate, all but four of the major rivers of the Pacific Northwest generally meet the goals of the Federal Water Pollution Control Act; however, three rivers have index numbers that are perilously close to the 6.0 that indicates unequivocal pollution. It is apparent that the more arid and agriculture oriented parts of the Region have the worst pollution. The Upper Snake River and its tributaries--the Boise and Portneuf Rivers--are three of the four worst polluted rivers in the Region. The fourth river, Spokane/Coeur d'Alene, is located in an intensive mining and smelting area. Other streams that flow through major agriculture areas include the Middle Snake, Yakima, and Bear Rivers. These streams have higher index numbers than most of the remaining rivers within the Region. Major coastal, major mountain, and Puget Sound rivers, with a few exceptions, have relatively good water quality. The exceptions, Green/Duwamish and Chehalis Rivers, flow through major populated areas.

The most prevalent of the eleven classes of pollution (see Table 5 below) that make up the index are excessive bacterial populations which indicate the possible presence of disease-related bacteria and viruses (Pathogenic indicators), excessive concentrations of phosphorus and nitrogen which have been documented to be the major nutrients responsible for eutrophication in the Region (Trophic potential), and excessive presence of suspended materials or oil and grease (Aesthetics). Each of these three classes of pollution was found to occur in half or more of the twenty-eight Pacific Northwest rivers that were analyzed for this report; and each at this time appears to be associated predominantly with runoff rather than waste discharges. High concentrations of toxic organic compounds such as pesticides, dissolved oxygen deficiencies, and elevated temperatures are also common. (The latter two are associated predominantly with reservoir conditions.) Supersaturation of dissolved gasses, heavy metals in toxic concentrations (toxic inorganics), salinity (dissolved minerals), and excessive acidity are also found, though they are rarer forms of pollution in the Pacific Northwest. No excessive concentrations of radioactivity were measured or suspected in the Northwest waters.

REGION 10
RIVER WATER QUALITY STATUS

Figure 7

AVERAGE MAINSTEM WATER QUALITY:

- **FAILS TO MEET FEDERAL GOALS**
- **PROVISIONALLY MEETS FEDERAL GOALS**
- **MEETS FEDERAL GOALS**

NOTE: Colors denote the average water quality index value for the entire river. In actuality, some stream reaches may be better or worse than indicated

STREAMS/REACHES

1. BEAR RIVER
2. UPPER SNAKE RIVER
3. PORTNEUF RIVER
4. MIDDLE SNAKE RIVER
5. BOISE RIVER
6. PAYETTE RIVER
7. LOWER SNAKE RIVER
8. ST. JOE RIVER
9. COEUR D'ALENE RIVER
10. SPOKANE RIVER
11. UPPER COLUMBIA RIVER
12. YAKIMA RIVER
13. UMATILLA RIVER
14. LOWER COLUMBIA RIVER
15. KLICKITAT RIVER
16. WILLAMETTE RIVER
17. SANTIAM RIVER
18. COWLITZ RIVER
19. WILLAPA RIVER
20. CHEHALIS RIVER
21. GREEN/DUWAMISH RIVER
22. SNOHOMISH RIVER
23. STILLAGUAMISH RIVER
24. NOOKSACK RIVER
25. UMPQUA RIVER
26. ROGUE RIVER
27. KLAMATH RIVER
28. CLEARWATER RIVER
29. SALMON RIVER

Selected stream/reach limits

Table 5 - Percent of Regional Rivers
Not Meeting Water Quality Criteria

Class	Criteria Group	Idaho	Oregon	Washington	Regional Avg.
1	Bacteria	50%	86%	77%	71%
2	Trophic potential	88%	86%	38%	64%
3	Aesthetics	38%	71%	46%	50%
4	Toxic organics	25%	71%	38%	43%
5	Dissolved oxygen	38%	29%	31%	32%
6	Temperature	25%	29%	15%	21%
7	Dissolved gasses	-	14%	23%	14%
8	Toxic inorganics	25%	-	15%	14%
9	Dissolved minerals	50%	14%	-	18%
10	Acidity/Alkalinity	13%	-	-	4%
11	Radioactivity	-	-	-	-

A pattern of change appears to be evolving in the nature of Pacific Northwest water pollution; though variations in flow, climate, and monitoring make any conclusions with respect to short term trends provisional. As seen on Table 6 below, those pollutants that have historically been associated with waste discharges--bacteria, nutrients, acidity, oxygen consuming substances, heavy metals from industrial operations--appear to be progressively less prevalent in Regional rivers. Conversely, pollutants that are associated with runoff, fallout, intense land use, reservoirs, and in-stream chemical reactions--toxic organic compounds, dissolved gasses, total dissolved solids--would appear to be increasing in prevalence and concentrations. Some of this apparent deterioration may be due to improved analytical capability in recent years.

Table 6 - Water Quality Trends of Regional Rivers

Class	Criteria Group	Improving*	Deteriorating*	No Change*
1	Bacteria	21%	11%	68%
2	Trophic potential	11%	7%	82%
3	Aesthetic	7%	7%	86%
4	Toxic organics	-	25%	-
5	Dissolved oxygen	7%	7%	86%
6	Temperature	-	-	-
7	Dissolved gasses	-	7%	-
8	Toxic inorganics	4%	-	-
9	Dissolved minerals	4%	7%	89%
10	Acidity/Alkalinity	4%	-	-

* Figure represents the precent of streams within the three states which are improving or deteriorating by criteria group. One stream may be improving with respect to one criteria group and deteriorating in another; therefore, it would be included in each listing. If 7% of the rivers in one criteria group are improving and 7% are deteriorating in the same group, then 86% experience no change at all.

The impression that may be derived from the data is that contemporary water pollution strategies based on waste treatment are proving effective with traditional pollutant sources but the more complex and resistant kinds of pollution that stem from intensive use of land and water may be offsetting some part of that improvement.

WATER QUALITY IN OREGON

A review of eight major Oregon rivers (Figure 8)--the river proper, not the entire drainage system--reveals a water quality pattern that is not inconsistent with that for all Pacific Northwest drainage basins. Marine waters are not included in this evaluation since present WQI techniques only apply to fresh water streams on a river mile basis. An attempt will be made to include marine waters in future reports.

Water quality, as reflected by index number, tends to improve progressively from east to west. Streams east of the Cascade Mountains are more highly utilized than the western streams. The highest pollution index number is that of the Columbia. The two coastal streams, the Rogue and the Umpqua, discharge waters to the Pacific that vary so slightly, or so infrequently, from the Federal criteria that they may be considered practically meeting water quality goals.

Aside from the dissolved gas supersaturation that causes the Columbia and Lower Snake to reveal the highest degree of pollution among the Oregon streams, there is a fairly uniform pattern of pollutant characteristics. Nutrient levels may be greater than are considered desirable in all streams but the Rogue and Umpqua. Bacterial populations rise above criterion concentrations in all but the Umpqua and Santiam. Turbididity (aesthetic) conditions are at times above criteria stipulations in all but the Willamette and Columbia. Organic toxicants occur in toxic concentrations in the Klamath. The differences that do occur are in the tendency for nutrient and temperature levels to be higher in eastern Oregon than western Oregon streams.

Even though the above problems do exist, all of these major Oregon rivers are well below the pollution index value of 6.0 that indicates an environment that is probably incapable of meeting the Federal goal of waters suitable for propagation of suitable species of fish, for the use of wildlife, and for unrestricted recreational employment. But though none achieves that unambiguously polluted condition, the Columbia's pollution index is greater than 4.0--primarily a result of dissolved gas supersaturation caused by spilling of flood season high flows over its numerous dams. The condition is definitely threatening to Columbia River salmon runs and must be considered significant. Nor should it be forgotten that the indicated degree of pollution applies to entire rivers. Isolated pockets or seasonal occurrences of pollution are found in almost all rivers.

Nonetheless, the picture of Oregon's water quality that emerges from the index and from consideration of particular pollutants and stream reaches is encouraging. Only the dissolved gas supersaturation of the Columbia stands out as a serious pollution feature.

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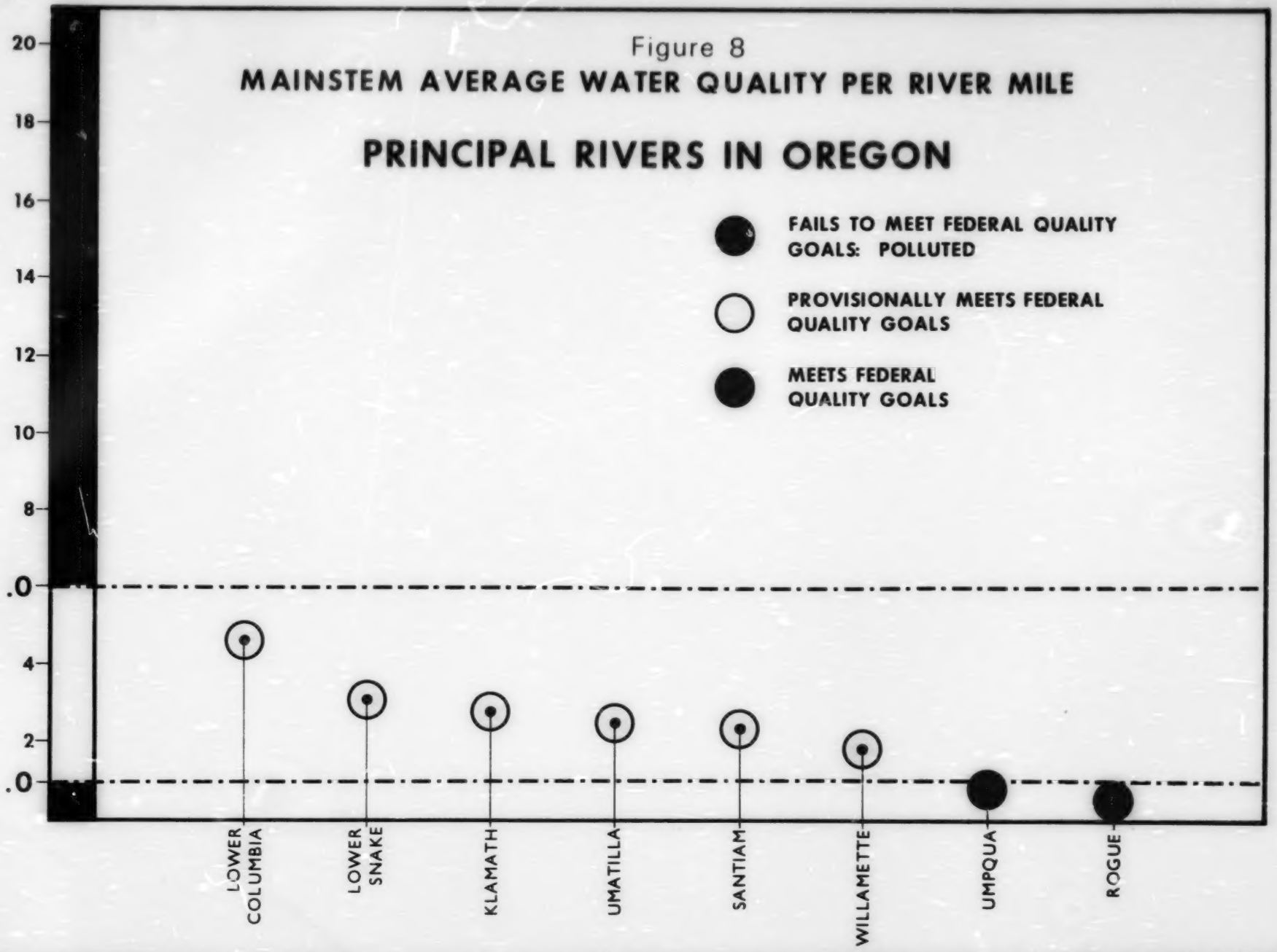
Figure 8

MAINSTEM AVERAGE WATER QUALITY PER RIVER MILE

PRINCIPAL RIVERS IN OREGON



POLLUTANT SOURCES: SUSPENDED SOLIDS

Suspended solid materials constitute the most abundant pollutant in the waters of the Pacific Northwest. An average of 260 million pounds per day are carried to the mouth of the Columbia, though the volume varies enormously with streamflow, precipitation, and reservoir operating patterns.

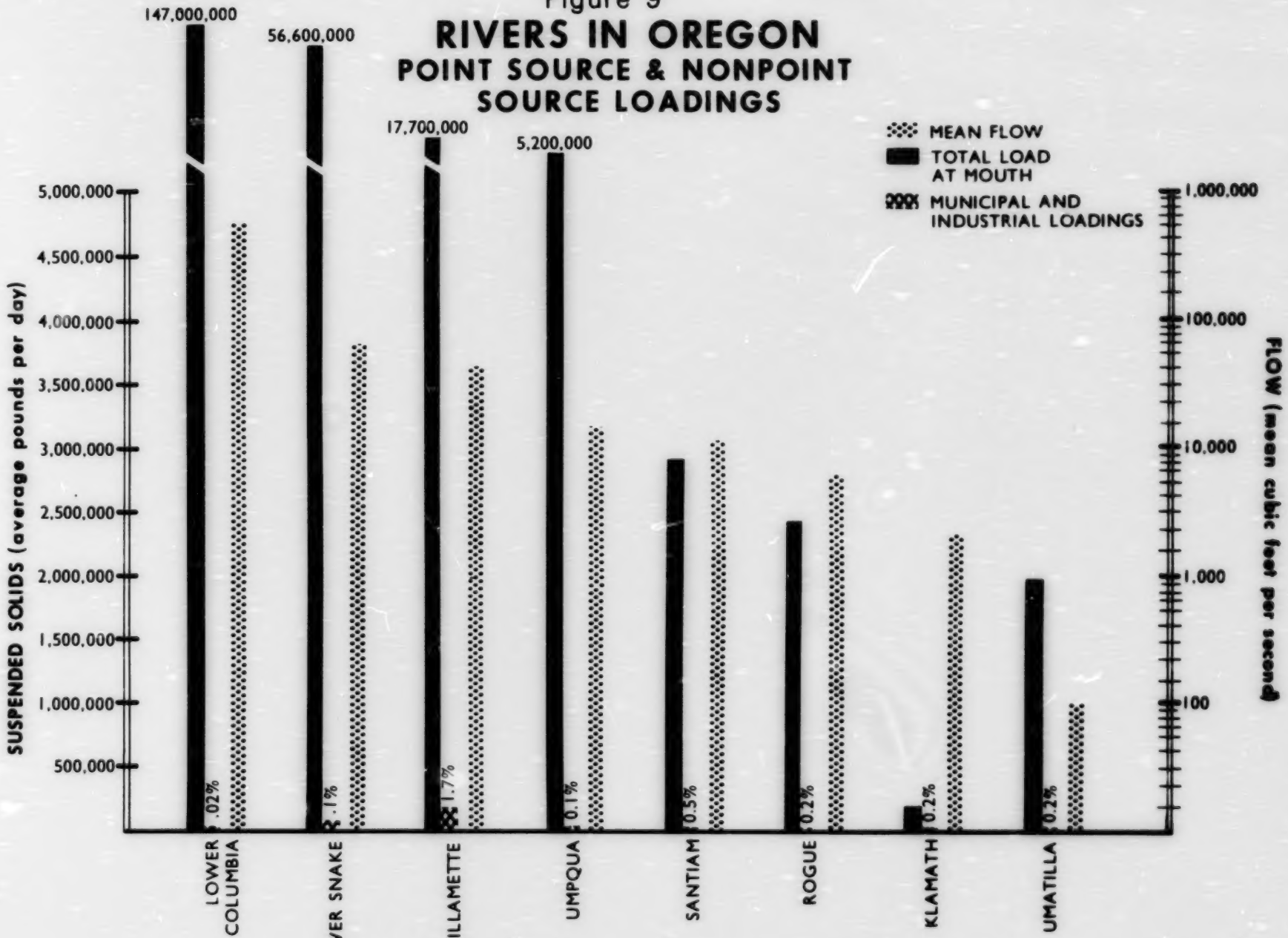
Suspended solids are not a single pollutant, but a general class of materials that are characterized by having a specific gravity close to 1.0. Thus they include both inert materials and organic matter--some of it, such as algae, living organisms. The specific polluting mechanisms of suspended solids are reduction of light penetration, discoloration, and with gradual settling, silting of fish spawning gravels and other ill effects of sediments. In addition to those specific effects of this general category of pollutant, suspended solids are indicators of other potentials for pollution: the organic fraction is degradable, so a source of oxygen demand; and suspended materials are carriers of both nutrients (primarily phosphorus) and of toxic materials which may be released.

There is a pattern to the production of suspended solids in Oregon rivers. The mean concentration of suspended solids in the rivers studied, as indicated by the average flows and solids in Figure 9, is about 125 parts per million parts of water; but the average values for those streams originating on the west slopes of the Cascades and flowing to the Columbia or directly to salt water are less than half of that. It is the relatively arid areas east of the Cascades, then, that are more productive of suspended solids.

Direct industrial and municipal waste discharges are an insignificant source of the pollutant. Aggregated waste discharges of suspended solids from point sources amounts to less than one tenth of one percent of the total suspended solids of all of the rivers studied--this in spite of an aggregation technique that significantly overestimates discharge-related solids loadings. (No allowance is made for settling or decomposition.) There is, however, a chain of biological reaction through which the effect of such discharges with respect to the total quantity of solids is amplified. Given favorable conditions, nutrient phosphorus from waste discharges can promote algal growth that is roughly 120 times the dry weight of the available phosphorus, with an even greater expansion of volume. Waste discharges may, then, be a substantial indirect source of suspended solids under some specialized circumstances.

Figure 9

RIVERS IN OREGON
POINT SOURCE & NONPOINT SOURCE LOADINGS



POLLUTANT SOURCES: BIOCHEMICAL OXYGEN DEMAND

Biochemical Oxygen Demand (BOD)--the rate at which oxygen is consumed by populations of aquatic bacteria that utilized dissolved organic materials as nutrients--has been used as the prime measure of a stream's pollution for the better part of a century.

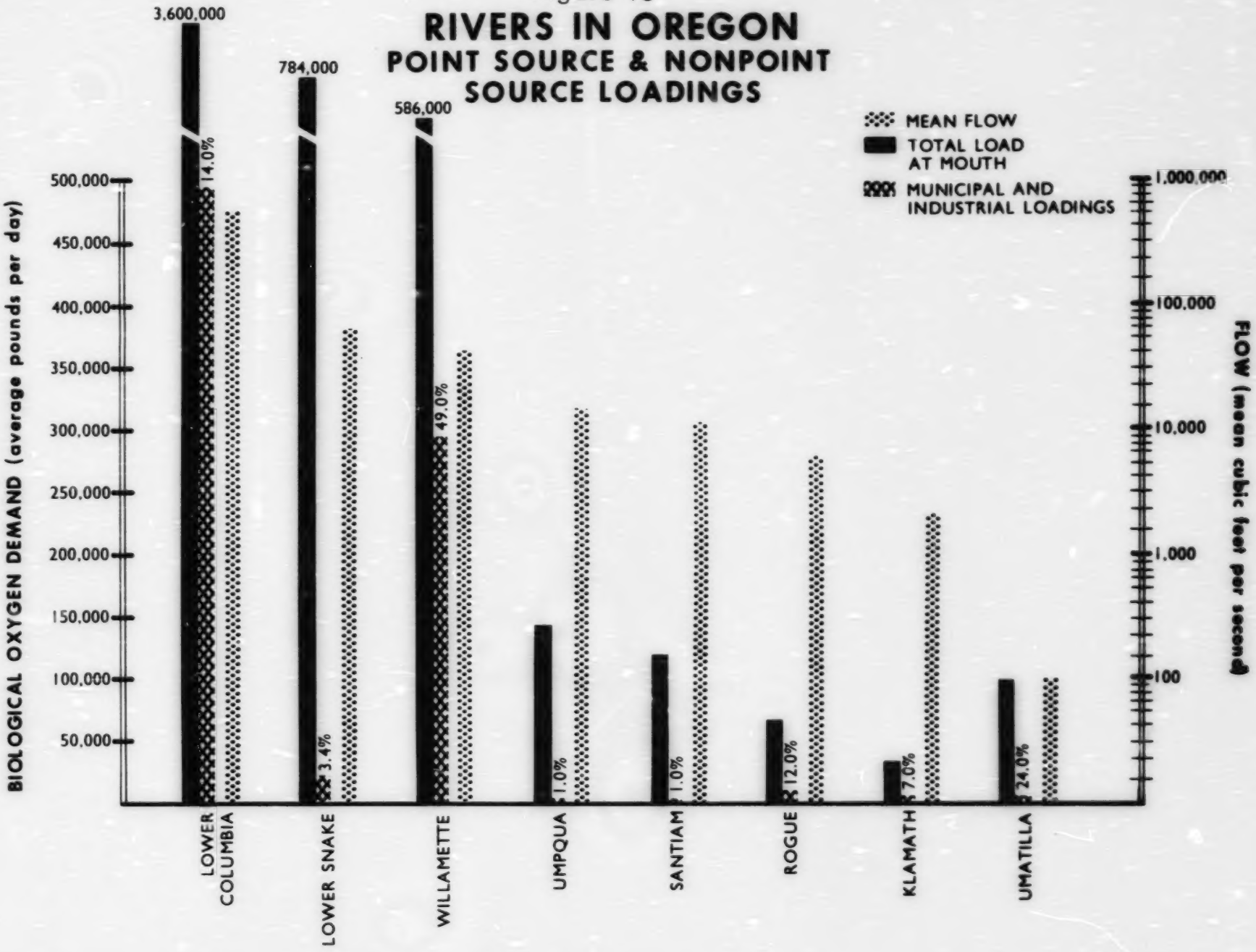
When exerted at a rate in excess of the rate of reoxygenation, biochemical oxygen demand may reduce the amount of oxygen that is dissolved sufficiently to change the composition of aquatic life forms in the area of the stream that is affected, as well as to reduce its level of biologic activity. The pollutant also serves as a measure of the potential organic enrichment of a stream, enrichment that may support regrowth of bacterial populations or contribute through decomposition processes to nuisance proliferation of algae and other water plants.

As the graph in Figure 10 demonstrates, all of the Oregon streams that were studied exhibited very similar mean biochemical oxygen demand levels. The average concentration was about two parts per million at the mouth for all of the rivers considered as a group; and the range about that mean was extraordinarily tight. The Santiam, with about 3.5 parts per million at the mouth, had the highest BOD values; the Rogue, at little greater than 1.5 parts per million, had the lowest. At the mouth, then, Oregon rivers uniformly seem to exhibit what are little more than natural background levels of organic materials. (Which is by no means inconsistent with the possibility of excessive BOD concentrations along the reach of some of the streams, since BOD is a reaction rate that is self-eliminating.)

What is extraordinary about the BOD regimens of these streams is the slight contribution that industrial and municipal wastes make to the total BOD loading. It has generally been assumed that BOD was essentially a measure of the strength of such point discharges; but even by a method that exaggerates their relative influence (sum of discharges over the length of the stream related to gross BOD exerted at the mouth) only two waterbodies--the Willamette and the Umatilla--demonstrate a significant contribution from waste discharges, and none derives a majority of its BOD from such discharges. For the group of waterbodies, little more than 15% of all BOD at the mouth can be attributed to industrial and municipal wastes. For half of the eight rivers, less than 10% can be attributed to discharges. Clearly, at the level of waste treatment achieved in Oregon, BOD production is analogous to that of suspended solids, with runoff and other natural mechanisms outweighing waste discharges in the transport of degradeable organics to streams.

Figure 10

RIVERS IN OREGON
POINT SOURCE & NONPOINT SOURCE LOADINGS



POLLUTANT SOURCES: TOTAL PHOSPHORUS

Phosphorus is present in Oregon streams in minute quantities--an average load of about 90,000 pounds a day at the mouth of the Columbia, as contrasted to 260 million pounds of suspended solids or the 4 million pounds of oxygen demand created by dissolved organic matter. Yet the amount is sufficient that phosphorus may be regarded as one of the more significant pollutants in Oregon waters.

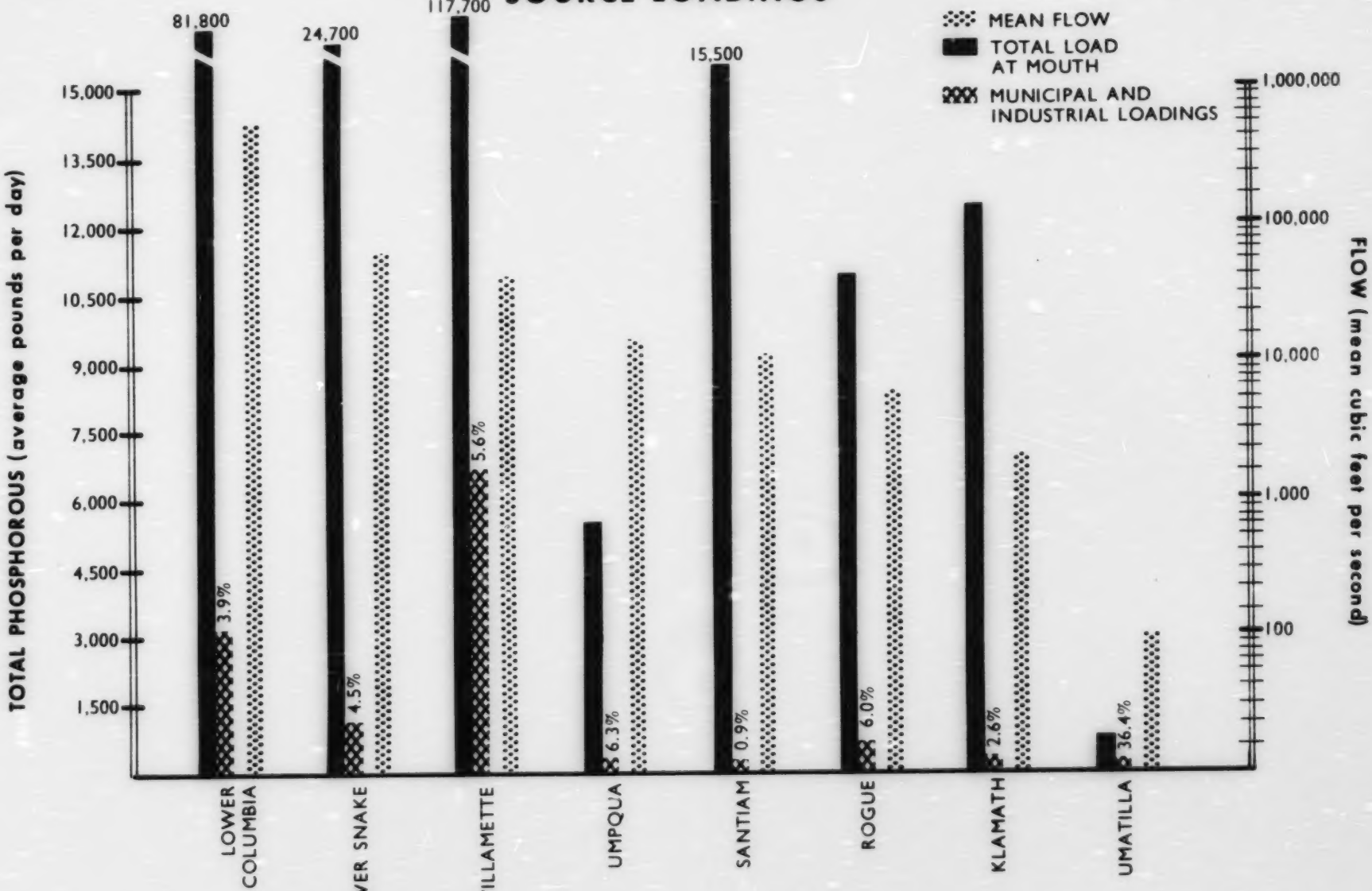
Phosphorus is not in itself a pollutant. Rather, it is the ability of phosphorus, as the critical nutrient, to support growth of nuisance levels of aquatic plants that makes it a potential problem. The approximate balance of the major chemical components of algae and other water plants is 106 parts carbon, 16 parts nitrogen, 1 part phosphorus. Since some aquatic plants can draw both carbon and nitrogen from the atmosphere, the effective limit of plant populations is often dictated by the amount of phosphorus dissolved in water; and each unit of phosphorus may trigger more than 120 times its weight in plant growth. The matter is not quite so simple as the above would make it seem. Trace nutrients and sunlight are also necessary for plant growth; and the form in which phosphorus occurs has a prime influence on its nutrient effect. Where dissolved phosphorus is immediately available as a nutrient, organically linked phosphorus becomes available gradually through decomposition processes, and soil bound phosphorus may never be available to plants unless released into the overlying water through chemical and bacteriological processes which occur under anerobic bottom conditions.

The pollutional aspects of excessive biological activity that stems from high nutrient levels are diverse. To some degree they may be merely aesthetic--stream discoloration and presence of clumped, floating water weeds--but more fundamental ecological alterations are also involved. Because of the photosynthitic respiratory cycle (plants give off oxygen in sunlight, consume it at night) variations in daytime and nighttime dissolved oxygen concentrations may occur that produce extreme stress on fish life. Similar diurnal variations in acidity and alkalinity may occur. Light penetration is reduced. Decay of dead material that settles in lakes and reservoirs may produce oxygen deficiencies. The enriched environment is favorable to regrowth of bacteria. Loss of species balance in fish populations follows from specialization of the organisms that fish feed upon. The taste and odor of water may be altered disagreeably, and carrying capacity of pipes and channels may be reduced.

The phosphorus production regimens of Oregon streams vary with location as can be seen on Figure 11. There is a rule of thumb that holds that, with the normal distribution of phosphorus forms, a concentration of .05 parts or more per million parts of water can result in nuisance algae growths. The Willamette and its tributary the Santiam exceed that threshold by a factor of about five. The two coastal streams, the Umpqua and the Rogue, are well below it, the Columbia moderately below it. The three eastern Oregon streams, the Lower Snake, Umatilla, and Klamath, are all well above it, with the Klamath demonstrating a concentration that is close to that for the Willamette.

Figure 11

RIVERS IN OREGON
POINT SOURCE & NONPOINT SOURCE LOADINGS



Overall, municipal and industrial waste discharges are a minor source of phosphorus, under 5% of the total for the eight Oregon rivers used in this analysis. Only the Umatilla derives a significant share of its phosphorus from such discharges. But those discharges may be a more significant contributant to pollution potential than their gross amount would suggest. The accelerated decompositon of organic matter that occurs in waste treatment results in a discharge whose phosphorus content is largely in solution, thus immediately available as a growth-triggering nutrient; while much, if not most, of the phosphorus originating with runoff is soil bound and not available to algae. Thus the form of sewage-related, and some industrial waste, phosphorus tends to give it a disproportionate pollutional effect.

WATER POLLUTION TRENDS

Figure 12 depicts the presence and trends of eleven broad classes of water pollution as they are revealed by the monitoring record for major Oregon rivers in the period 1971 through 1975.

A blue box indicates that measurements for the indicated class of pollutant produced no evidence of a violation of Federal criteria for water suitable for fish, wildlife, and recreation. Yellow and red boxes indicate respectively that there were relative minor and major violations of the criterion. The color determination takes into account the frequency and magnitude of the violation as well as the water quality sampling frequency. An upward pointing arrow within the box indicates measurements that show either that the concentration of the particular pollutant is rising or that the frequency of criterion violation is increasing--that is, that the propensity for pollution to occur is rising. (A downward pointing arrow would indicate a decline in the propensity for pollution.) A circle within the box indicates a judgment based on knowledge of pollutant sources rather than actual water quality measurements.

As the graph demonstrates, the most common criteria violations in Oregon are those derived from temperature, bacteria counts, aesthetics in the form of suspended solids, and trophic conditions in the form of nutrients. The most worrisome aspect of the display, perhaps, is the rising trend for organic toxicants even though the levels are not yet critical.

Dissolved gas supersaturation is the most serious form of pollution in Oregon waters because of its catastrophic and widespread effect on salmon populations, and it appears to be increasing on the two rivers in which it is known to occur.

Other pollutant presence seem to be stable or declining. In fact, the State's water quality situation seems to display a static balance. Of eighty-eight opportunities for pollution (eleven pollution classes, eight studied rivers) twenty-nine suggest that some degree of pollution is, in fact, realized. In nine of the eighty-eight the propensity for pollution seems to be rising; in seven it appears to be declining.

In view of the generally high water quality that predominates in Oregon, the static balance may not be unfavorable--though it is clearly less than ideal. There are, however, disturbing implications in the distribution of improving and declining pollution indicators. Improvements are concentrated in bacterial factors where current adverse effects may be considered to be slight. Worsening conditions are dominated by dissolved gas supersaturation, dissolved solids, aesthetics, and concentrations of toxic organic materials that may have serious and far reaching effects on aquatic ecosystems.

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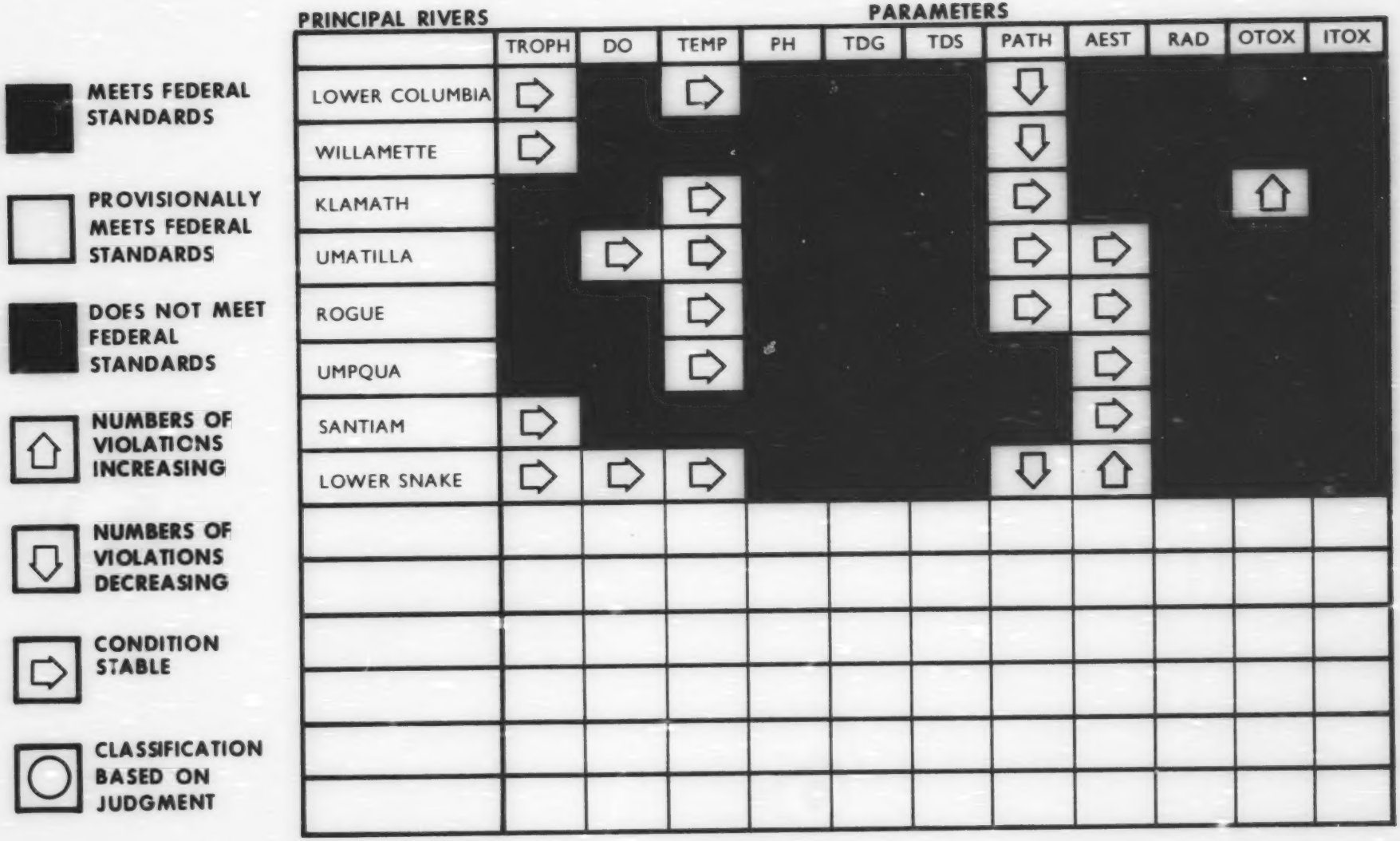
Figure 12

RIVERS IN OREGON

FEDERAL CRITERIA VIOLATIONS



NEAR TERM OUTLOOK

Consideration of the nature, location, sources, and trends of water pollution in the State of Oregon must lead to the conclusion that little significant change can be anticipated in the next three to five years.

The assessment is almost inescapable. With minor exceptions, the water quality problems of Oregon do not stem from point source waste discharges, which constitute the near exclusive focus of contemporary water pollution abatement programs, but from runoff and reservoir conditions. Man's activities contribute to the pollutional aspects of natural runoff; but, for the most part, measures to reduce those contributions remain to be defined. And as such definitions occur and are adopted in the State, it must be anticipated that they will be offset to some degree by sheer growth in the scale of human activities and by the complications posed by the proliferation of toxic organic compounds. There will, in short, be no convenient technical solution like waste treatment with which to deal with most of Oregon's remaining and emerging water quality problems.

But if recognition of the limited marginal effects of waste treatment, the significance of non-point sources of pollution, and the difficulities of dealing with such sources leads to the conclusion that no major change in Oregon's water quality is in the offing, that must be recognized to be an optimistic conclusion. There has been serious water pollution in Oregon. It has been largely--not entirely--eliminated. The major task of water quality management in the State at this time is protection and preservation of the excellent water quality that predominates. So to preserve existing water quality would be a major achievement. To extend it would be quite remarkable.

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